Manual No. 91000064-004
Revision A
August 29, 2001

The *Mega*Plus®
Model ES 1.0 Series Cameras
User's Manual

(Models ES 1.0,ES 1.0/PIV, ES 1.0/SC, ES 1.0/10 Bit, ES 1.0/TH)

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List of Manual Revisions

User's Manual – Model ES 1.0 Series, Part Number 91000064-002

Revision	Date	EO No.	Notes
A	08-29-01		Reissued to reflect Redlake MASD, Inc. change, new flexible cable for tethered head, new format, and general cleanup.

RELATED DOCUMENTS

*Mega*Plus Model ES 1.0 Remote Control Panel User's Manual, Part #91000074-001

FCC DECLARATION OF CONFORMITY

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Subpart B of Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This equipment has been certified to comply with the limits for a Class A computing device, pursuant to FCC rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of the manufacturer could void the user's authority to operate this equipment.

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PRECAUTIONS

CAUTION: A laser beam focused on the sensor, either directly or by reflection, can cause permanent damage to the sensor. Any laser powerful enough to produce localized heating at the surface of the sensor will cause damage, even if the camera power is off. A sensor damaged by laser light is NOT covered by the warranty.

NOTE: The ES 1.0 Series Cameras require a minimum of 10 minutes warm up time prior to operation. Images taken before the camera has warmed up sufficiently may show artifacts. Waiting until the camera has warmed up will ensure that the camera performs within specified parameters.

OPERATING TEMPERATURE

The *Mega*Plus camera is designed to operate satisfactorily in an environment where the ambient temperature is between 0° and 40°C (32° and 104°F), with no water condensation present.

STORAGE TEMPERATURE

Do not store the equipment in an area where the temperature will drop below –25°C (-13°F) or exceed 80°C (176°F). Do not allow moisture to condense on the system.

SHIPPING

When shipping, use a carton that protects the camera from shock and moisture, similar to the carton in which the unit was originally delivered. Do not ship the equipment in a cargo area where the temperature will drop below -25°C (-13°F) or exceed 80°C (176°F). Do not allow moisture to condense on the system.

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1. INTRODUCTION

1.1 Introduction

With spatial resolution of one million pixels, 30 frames per second (fps), and dual channel progressive scan readout, the Redlake MASD, Inc. *Mega*Plus Camera, Model ES 1.0, is well suited for scientific and industrial imaging applications. The compact camera package operates through an AIA connection to a host computer. The AIA interface connector, located on the camera's rear panel, sends eight-bit digital output video to the computer and receives control commands from the computer.

Featuring an interline Charge Coupled Device (CCD) sensor array, the camera has 1,008 (H) x 1,018 (V) light sensitive elements (pixels). These pixels have a center-to-center spacing of 9 microns with a 60% fill ratio. The Model ES 1.0/PIV camera has been modified for use in particle image velocimetry. This model has an active pixel area of 900 (H) x 900 (V).

The camera operates continuously or in a triggered mode. Minimum exposure times of 0.127 milliseconds are possible with the camera's electronic shutter. The frame rate is unaffected by the exposure time. The camera has an output channel data rate of 20 MHz, which gives a maximum frame rate of 30 fps. The camera requires only eight watts of power and can be connected to many commercially available frame grabber boards capable of handling eight or ten bits of video data. The ES 1.0 camera's triggered double exposure mode facilitates Particle Image Velocimetry (PIV).

In dual channel mode, the camera outputs two lines of the image simultaneously. The camera is limited to single channel operation and 15 fps when ordered as a Redlake MASD, Inc. *Mega*Plus Camera, Model ES 1.0/SC.

1.2 How to Use This Manual

WARNINGS, CAUTIONS and NOTES
As you read this manual, you will notice that some of the information is presented as a WARNING, CAUTION or NOTE. It is important that you understand the significance of these terms.

A **WARNING** is important to the safety of anyone operating the Camera and should not be disregarded under any circumstances.

A **CAUTION** is intended to alert you to an operation or condition that may cause loss of data or harm to your Camera.

A **NOTE** contains information that is important to the operation of your Camera.

Chapter 1 contains an explanation of this manual and a warranty statement.

Chapter 2 explains the function of the controls and connectors of the *Mega*Plus Camera.

Chapter 3 contains the commands used to operate the camera. The camera is remotely operated by entering commands into a computer connected to the camera.

Chapter 4 details the signals carried by the AIA interface connector, including timing waveforms.

NEW EQUIPMENT WARRANTY
REDLAKE MASD, INC. *MEGA*PLUS CAMERA

REDLAKE MASD, INC. (HEREAFTER REFERRED TO AS REDLAKE) WARRANTS THIS CAMERA, AND ACCESSORIES MANUFACTURED BY REDLAKE, TO FUNCTION PROPERLY FOR ONE YEAR FROM THE DATE OF SHIPMENT.

Redlake agrees to perform the following equipment warranty services in the United States.

1. Repair service: if shipped to us, repairs will be made at no charge.
2. Parts replacement: replacement parts installed under warranty will be provided at no charge.

THIS WARRANTY DOES NOT APPLY TO THE FOLLOWING CONDITIONS:

- Failure to operate the *Mega*Plus Camera, in accordance with Redlake's written instructions, including environmental specifications listed in the User's Manual.
- Evidence of the Camera being subjected to accidental damage, misuse or abuse.
- The Camera, having been repaired or tampered with by persons other than Redlake personnel, customer personnel trained by Redlake or without permission of Redlake.
- Shipping damage is not covered by this warranty. The purchaser has the responsibility to place a claim of damage in shipment with the carrier.

REDLAKE MASD, INC. MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED, OR OF MERCHANTABILITY FOR THIS EQUIPMENT. IF THIS CAMERA DOES NOT FUNCTION PROPERLY DURING THE WARRANTY PERIOD, REDLAKE WILL REPAIR IT WITHOUT CHARGE ACCORDING TO THE TERMS STATED ABOVE. REPAIR WITHOUT CHARGE IS REDLAKE'S ONLY OBLIGATION UNDER THIS WARRANTY. REDLAKE WILL NOT BE RESPONSIBLE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES RESULTING FROM THE SALE, USE OR IMPROPER FUNCTIONING OF THIS EQUIPMENT EVEN IF LOSS OR DAMAGE IS CAUSED BY THE NEGLIGENCE OR OTHER FAULT OF REDLAKE.

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2. CONTROLS AND CONNECTORS

2.1 Camera

NOTE: A lens cap is installed on each camera to keep dust from getting on the optical sensor or components when it is shipped. Remove the lens cap and install your lens in a dust free environment.

2.1.1 Mounting the Camera

The *Mega*Plus camera has a ¼-20 threaded screw hole for mounting purposes on the bottom of the camera body (see Figure 2-1). There is a second hole, 0.228 inches in diameter, to accommodate a locating pin. The tethered head mounting holes, two on each of the four sides, are also shown in Figure 2-1.

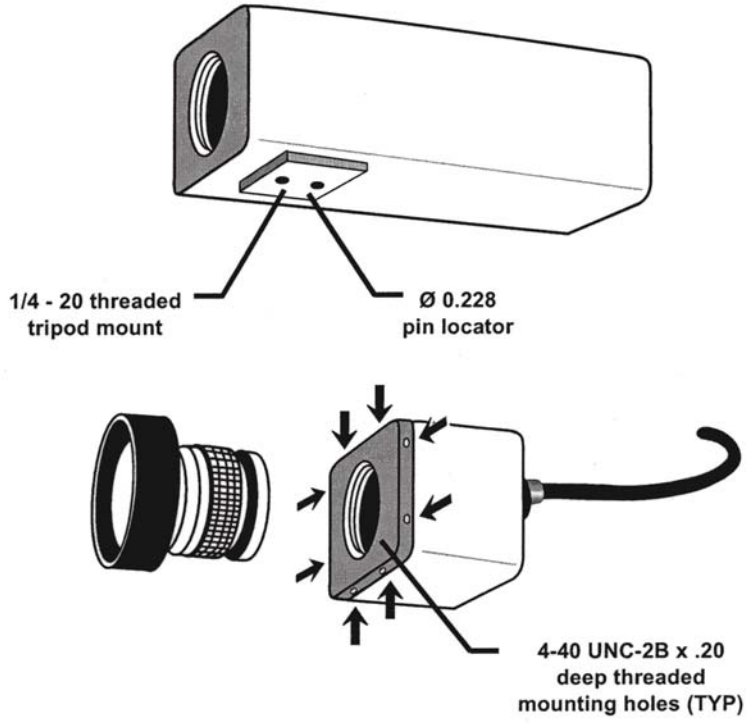

Figure 2-1. Camera Body Bottom and Tethered Head Mounting Holes

2.1.2 Attaching the Lens

The camera uses a C-mount lens. Screw the lens clockwise into the lens mount until you are no longer able to turn the lens with light pressure.

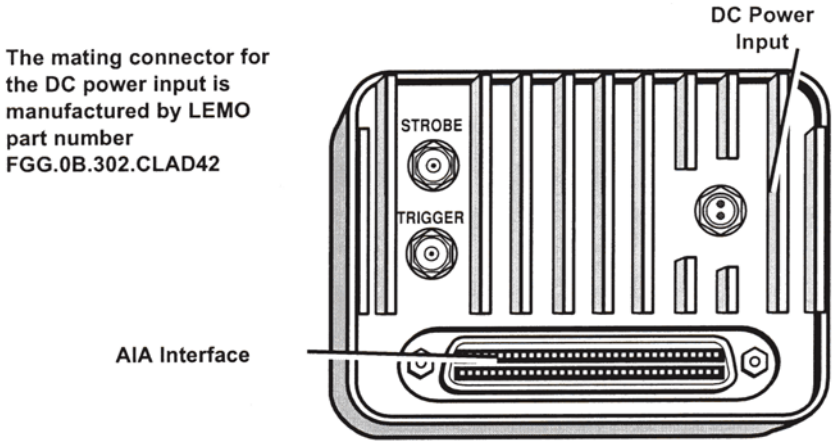
DC Power Input
The mating connector for the DC power input is manufactured by LEMO part number FGG.0B.302.CLAD42
STROBE
TRIGGER
AIA Interface

Figure 2-2. ES 1.0 Rear Panel

2.2 Camera Rear Panel

2.2.1 AIA Interface

The AIA Interface is a 68-pin, high density, dual row, D type connector that connects the camera to a frame grabber board and a serial communication interface for camera control. The frame grabber board processes and displays video from the camera. A complete technical description of the connector and the signals that it carries is contained in Chapter 4 of this manual.

2.2.2 Trigger

The TRIGGER coaxial SMA type input connector on the rear panel of the camera accepts CMOS TTL signals with a threshold of approximately 2.5 volts. The trigger pulse should have a duration of at least 300 nanoseconds and should be transmitted to the camera using a coaxial cable terminated at the camera. The camera synchronizes to an external event using this input. The operator can set the camera to respond to a positive or negative going trigger signal. See the timing waveforms in Chapter 4 of this manual.

2.2.3 Strobe

The STROBE coaxial SMA type connector on the rear panel of the camera outputs a signal that is TTL compatible and can drive a 50-ohm load. The strobe output pulse should be transmitted through a coaxial cable with a terminating resistor at the receiving end. The leading edge of this output signal can be used to fire a strobe light. The output signal polarity is user-definable. See the timing waveforms in Chapter 4 of this manual.

2.2.4 DC Power Input

The DC power input is a two-pin connector. The power supply voltage should be between 12 and 28 volts DC measured at the camera's power connector. The current draw is a maximum of 0.8 amps at the lowest input supply voltage and 0.3 amps at the highest input supply voltage.

WARNING!

Reversing the polarity of the DC voltage input, or voltage levels in excess of 30 volts, may permanently damage the camera

2.3 Cables

There are three different cables available to connect the *Mega*Plus Camera to your computer, as shown in Figure 2-3 below.

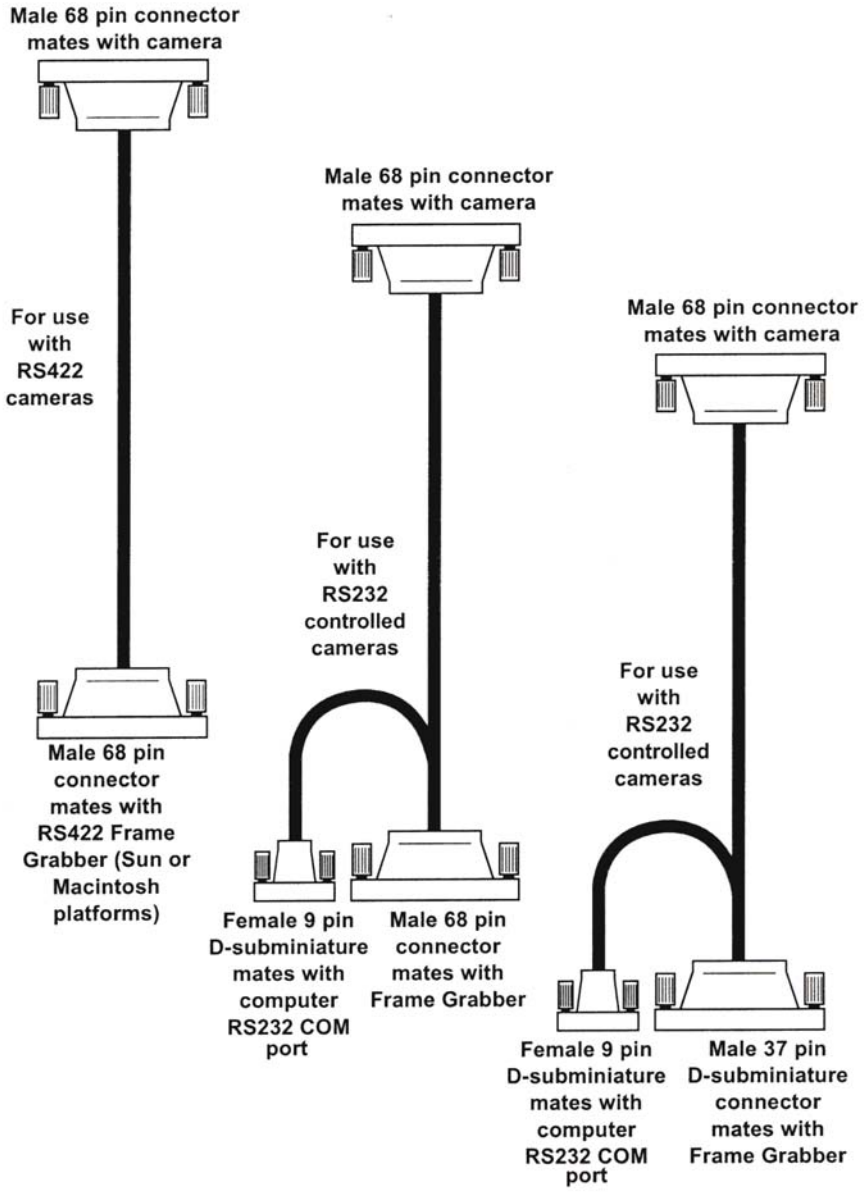
Male 68 pin connector mates with camera
For use with RS422 cameras
Male 68 pin connector mates with RS422 Frame Grabber (Sun or Macintosh platforms)
Male 68 pin connector mates with camera
For use with RS232 controlled cameras
Female 9 pin D-subminiature mates with computer RS232 COM port
Male 68 pin connector mates with Frame Grabber
Male 68 pin connector mates with camera
For use with RS232 controlled cameras
Female 9 pin D-subminiature mates with computer RS232 COM port
Male 37 pin D-subminiature connector mates with Frame Grabber

Figure 2-3. ES 1.0 Cable Types

2.4 Hardware Setup

Follow the instructions supplied by the frame grabber manufacturer when you are using their cables to install your camera. If using Redlake supplied cables, connect the camera as shown in Figure 2-4 below.

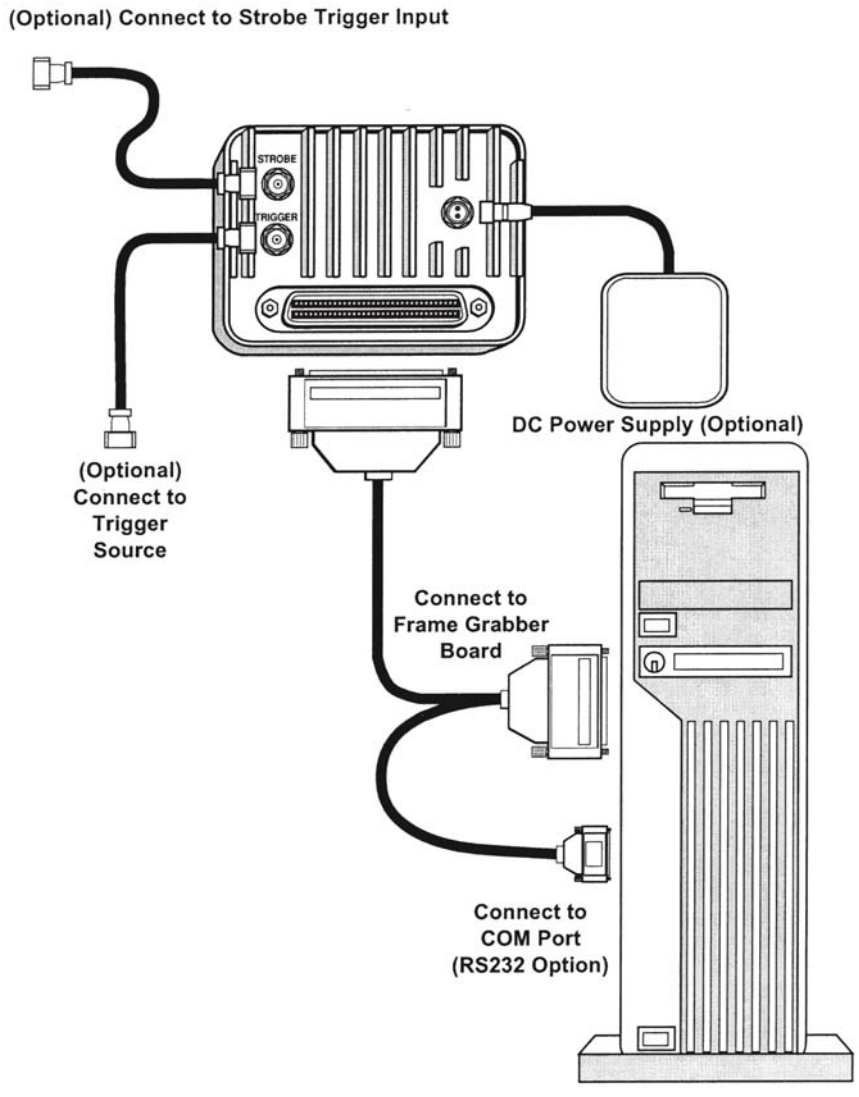

Figure 2-4. Component Connection Diagram

2.5 Routine Maintenance

There are no user serviceable parts inside the camera. The camera must be returned to the factory for repair if a malfunction occurs.

The lens and the sensor cover glass should be cleaned according to good photographic practices.

The camera can be ordered from the factory with an infrared filter installed in the lens mount. If an infrared filter was not ordered originally, a piece of clear glass will be installed in place of the filter. The filter or its glass replacement keep the sensor sealed from dust and must be removed in a clean room environment. A single speck of dust on the sensor is very noticeable because of the high resolution of the camera.

Clean the exterior of the camera with a soft, dry, lint-free cloth. For stubborn dirt, the cloth may be dampened with a mild soap solution.

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3. CAMERA OPERATION

3.1 Introduction

The *Mega*Plus camera, Model ES 1.0, does not have any manual controls on the camera itself. Camera operation is accomplished by commands sent to the camera through a serial data link from a personal computer (PC). The camera serial data link may be ordered from the factory as either RS232 or RS422. In either case, the command syntax is the same.

A list of the camera functions, commands and appropriate page numbers follows:

NOTE:	The commands can be entered in either upper or lower case.

FUNCTION	COMMAND	PAGE
Readout Channels	RDM	3.2
Mode Command	MDE	3.5
Exposure	EXE	3.5
Trigger	TRS, TRM, TRE	3.6
Transfer Pulse Delay	TPD	3.7
Transfer Pulse Width	TPW	3.7
Black Level	BKE	3.8
Black Level Balance	BKB	3.8
Digital Gain	DGN	3.9
Gain Balance	GAB	3.9
Restore Factory Settings	RFS	3.9
Strobe Polarity	STP	3.10
Defect Conceal	DEF	3.10
Save	SAV	3.10
Reset	RST	3.10
Display Wedge	WDG	3.11
Status Query	STS	3.11
Identification Query	IDN	3.11

3.2 Serial Communications Protocol

The camera uses a full duplex UART type asynchronous system, using standard nonreturn-to-zero (NRZ) format (one start bit, eight data bits, one stop bit, no parity). The baud rate is fixed at 9600. The character code is based on the ASCII standard.

The character flow control protocol is XON/XOFF. XON is assigned DC1 (control-Q) and XOFF is assigned DC3 (control-S). The receiver sends the XOFF character when it wants the sender to pause in sending data and an XON character when it wants the sender to resume.

The camera will recognize a command as three command characters, followed by a space character, followed by an argument that consists of one or more characters, ended by the carriage return and line feed characters. The camera responds to a valid command with a carriage return and line feed (CR-LF).

The camera will recognize a query as three command characters, followed by the question mark character, then ended by the carriage return character.

The camera responds to a query with three command characters, followed by a space bar character, followed by an argument that consists of one or more characters, then ended by a carriage return and line feed (CR-LF).

3.3 Error Messages

The camera can respond to an erroneous command or query in one of four possible ways.

MESSAGE FROM CAMERA	EXPLANATION
ERROR-SYNTAX	The camera cannot make sense of the command
ERROR-ARG OUT OF RANGE	The command is recognized, but the argument is out of range or indecipherable
ERROR-XMIT	The receiver detected a transmission error such as buffer overflow, parity, or framing
ERROR-HARDWARE ERROR	An internal hardware error was detected

3.4 Control Commands

NOTE: This section of the manual contains the commands and arguments in bold type. The carriage return and line feed at the end of each command are not shown, as they are required in every instance.

3.4.1 Readout

The camera has two readout options: dual channel and single channel. This command is used to switch between the two readout options. This command can only select dual channel readout if you purchased a camera with dual channel capability (All models except ES 1.0/SC).

TYPE IN:	RESPONSE	EXPLANATION
RDM 1	CR-LF	Sets the camera to single channel readout
RDM 2	CR-LF	Sets the camera to dual channel readout
RDM?		Queries the camera's current readout
	RDM x	Means the readout is set as indicated

3.4.2 Mode Control

The *Mega*Plus camera operates in one of four modes: continuous, controlled, trigger, or triggered double exposure. The mode of operation is selected by the MODE command. The timing waveforms in Chapter Four may help you understand the different modes of operation.

3.4.3 Continuous

The camera will take pictures at 30 fps in dual channel mode and 15 fps in single channel mode. The frame rate is fixed and is not varied by the exposure setting. The camera can be synchronized to an external trigger source through the TRIGGER input on the rear panel of the camera or the EXPOSE input of the AIA interface connector. The trigger input frequency must be between 29.5 and 30.5 Hz. If the camera is not externally triggered, its frame rate will be 29.5 fps. When multiple cameras are driven from the same trigger source, they will be synchronized to each other within ± 100 nanoseconds. The digital video output is paused for one line time at the time the exposure starts for the next frame. See continuous mode timing diagram in Chapter 4 for details.

The exposure time range is between 125 microseconds and 33 milliseconds in dual channel operation. Maximum exposure time increases to 66 milliseconds in single channel mode.

3.4.4 Controlled

The start and exposure time of each image is controlled directly by the user. Control is accomplished by the EXPOSE input pins in the AIA interface connector or the Trigger input on the rear panel of the camera. The exposure time is equal to the time the EXPOSE input signal is true. The frame rate is inversely proportional to the exposure plus readout time. The exposure time is unlimited, but at room temperatures, dark field non-uniformities become noticeable with exposure times greater than 100 milliseconds.

3.4.5 Trigger

Each exposure is started by a signal connected to the EXPOSE input pins of the AIA interface connector or the Trigger input on the rear panel of the camera. The exposure command sets the exposure time. An exposure starts 20 microseconds (± 100 nanoseconds) after the active edge of the trigger pulse and ends at the exposure time selected by the EXE command. The active edge of the trigger pulse is selected using the TRM command.

The EXPOSE input sets the start time for each frame of video. The camera will ignore additional EXPOSE signals until it completes the current exposure. The trigger mode of operation is used to capture a single image or a sequence of images.

3.4.6 Triggered Double Exposure

Triggered double exposure is used in Particle Image Velocimetry (PIV) because of the short time between successive exposures. A triggered double exposure starts with the user-supplied trigger as illustrated in Figure 3-1 below.

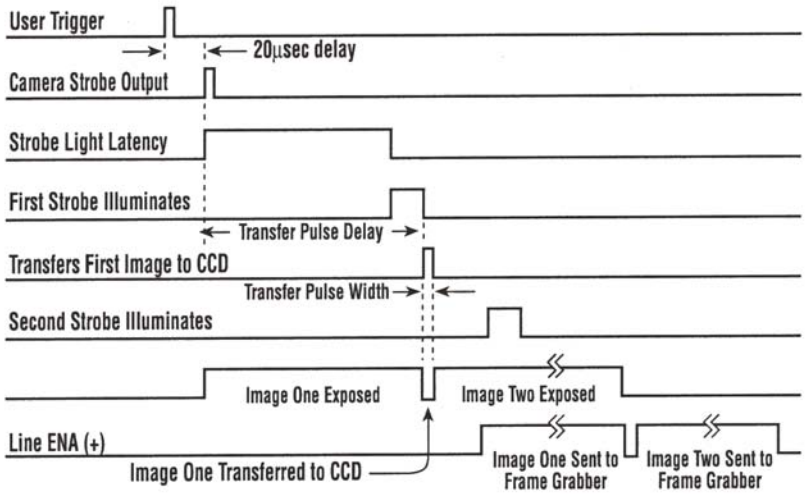

Figure 3-1. Triggered Double Exposure Timing

Two images are captured in rapid succession by the camera in the triggered double exposure mode. This is accomplished by capturing the first image in the photo diode array, transferring this image to the CCD array, and then capturing a second image in the photo diode array. The first image is transferred from the CCD to the frame grabber while the second image is being captured by the photo diode array. The second image is then transferred into the CCD array and then on to the frame grabber's second image buffer.

Strobes have a light output delay that can be from zero to several microseconds. Obtain this information from the manufacturer or determine the delay by experiment. This time plus allowance for light duration must be programmed into the camera via the command TPD (Transfer Pulse Delay).

The user must use the strobe output pulse, delayed through a pulse generator, to fire the second strobe within 33 milliseconds (66 milliseconds in single channel mode) after the transfer pulse.

The first image has an exposure period from 1 to 33 milliseconds, as set by the TPD command and that the second image has a fixed exposure period of 33 milliseconds. It is therefore necessary to conduct the experiment in a dark environment where the strobe illumination dominates.

The transfer pulse width internal to the camera is normally 5 microseconds. As the time between exposures is reduced below 5 microseconds, the transfer pulse width must be reduced by the same factor. The Transfer Pulse Width is set by the TPW command.

3.4.7 Mode

Use this command to set the camera mode of operation.

TYPE IN:	RESPONSE	EXPLANATION
MDE CS	CR-LF	Sets the mode to continuous.
MDE CD	CR-LF	Sets the mode to controlled.
MDE TR	CR-LF	Sets the mode to trigger.
MDE DE	CR-LF	Sets the mode to triggered double exposure.
MDE?		Queries the current mode setting.
	MDE xx	Means the mode is set as indicated.

NOTE: The FRS command sets the maximum frame rate limit in controlled and continuous modes. FRS must be set to 15 in double exposure mode.

3.4.8 Exposure

This command sets the camera exposure time in increments of 0.0636 milliseconds. The argument for this command must be an integer value from 2 to 510 in dual channel mode, or 2 to 1020 in single channel mode. The corrected exposure time in milliseconds to three decimal places is returned in response to a query. The exposure time setting is valid for the continuous and trigger modes only. If the TPD command was executed with a value of 0, the time set by the EXE command becomes the transfer pulse delay.

TYPE IN:	RESPONSE	EXPLANATION
EXE xxxx	CR-LF	Sets the exposure in integer increments of 0.0636 milliseconds. The argument range is from 2 to 510 (30 fps) or 2 to 1020 (15 fps).
EXE?		Queries the current exposure setting. The value returned will be in milliseconds and equal to 0.0636 times the integer value entered with the last EXE command.
BNS?		Queries the current binning selection.
	EXE xxxx	Means the exposure is set as indicated, expressed in milliseconds.

Sample Commands with Arguments:

EXE 2 Sets the exposure or transfer pulse delay to 0.127 millisecond.
EXE 8 Sets the exposure or transfer pulse delay to 0.508 millisecond.
EXE 16 Sets the exposure or transfer pulse delay to 1.017 milliseconds.
EXE 158 Sets the exposure or transfer pulse delay to 10.048 milliseconds.
EXE 510 Sets the exposure or transfer pulse delay to 32.436 milliseconds.
EXE 1020 Sets the exposure or transfer pulse delay to 64.872 milliseconds (15 fps only).

3.4.9 Trigger

This command selects the trigger source and polarity. There are two trigger inputs: the SMA connector on the rear panel of the camera (labeled TRIGGER), and the EXPOSE input carried by the AIA interface connector.

TYPE IN:	RESPONSE	EXPLANATION
TRS AIA	CR-LF	Selects the AIA interface connector EXPOSE signal as the trigger source.
TRS EXT	CR-LF	Selects the TRIGGER connector on the rear panel as the trigger source.
TRS?		Queries the trigger source.
TRM P	CR-LF	A positive going edge at the AIA EXPOSE input trigger connector will start an exposure. This command automatically enables the EXPOSE input if it was disabled when this command is issued.
TRM N	CR-LF	A negative going edge at the AIA EXPOSE input or the trigger connector will start an exposure. This command automatically enables the EXPOSE input if it was disabled when this command is issued.
TRM?		Queries the current EXPOSE polarity
	TRM P	Means a positive going edge at the EXPOSE input triggers the camera.
	TRM N	Means a negative going edge at the EXPOSE input triggers the camera.
	TRM O	Means EXPOSE input port has been disabled. This can only occur if TRE 0 or TRE 1 has been executed.
TRE 0	CR-LF	Starts an exposure and disables the EXPOSE input. Use the TRM command to enable the EXPOSE input.
TRE 1	CR-LF	Stops an exposure and disables the EXPOSE input. Use the TRM command to enable the EXPOSE input.
TRE?		Queries current state of trigger command.
	TRE 0	Means an exposure is taking place.
	TRE 1	Means the camera is in the transfer frame and then idle state.

3.4.10 Transfer Pulse Delay

This command sets the time between the initial edge of the strobe pulse to the initial edge of the transfer pulse in the triggered double exposure mode only.

TYPE IN:	RESPONSE	EXPLANATION
TPD xxx	CR-LF	Sets the delay in increments of 1 microsecond. The argument range is from 1 to 999 microseconds. If TPD is set to zero, the EXE value controls the first image exposure time permitting equal exposure time for both images.
TPD?		Queries the current transfer pulse delay time setting.
	TPD xxx	Means the time is set as indicated.

Sample Commands with Arguments:

TPD 0 The time set by the EXE command becomes the transfer pulse delay.
TPD 1 Sets the delay time to 1 microsecond.
TPD 999 Sets the delay time to 999 microseconds.

3.4.11 Transfer Pulse Width

This command sets the time of the transfer pulse in the triggered double expose mode only.

TYPE IN:	RESPONSE	EXPLANATION
TPW x	CR-LF	Sets the delay in increments of one microsecond. The argument range is from .2 to 5 microseconds.
TPW?		Queries the current transfer pulse width setting.
	TPW x	Means the time is set as indicated.

Sample Commands with Arguments:

TPW .2 Sets the delay time to .2 microseconds.
TPW 5 Sets the delay time to 5 microseconds.

3.4.12 Black Level

The black level control functions much like the brightness control on a television set. The fixed video black level is set at the factory so that the output video is just above the black clipping level with the lens capped. The black level can be varied over a range of plus or minus 50 percent of peak white video.

TYPE IN:	RESPONSE	EXPLANATION
BKF	CR-LF	Sets the black level to an internal fixed value of approximately 10 counts above zero.
BKE xxxx	CR-LF	Sets the black level with xxxx ranging from 1365 to –2730.
BKE?		Queries the current black level setting.
	BKF	Means the black level is at the factory preset level.
	BKE xxxx	Means the black level is set to the value indicated.

NOTE: The video will be clipped to zero counts until it overcomes a negative offset. The video will be shifted towards white by a positive offset.

3.4.13 Black Level Balance

The black level of the two output video channels must be closely matched to minimize line-to-line shading. The black level balance command adjusts the black level of one channel with respect to the other. The adjustment range is from –128 to 127. With the camera in dual channel readout operation and the lens capped observe the video monitor and change the black level balance until you are satisfied with the pictures that you see.

TYPE IN:	RESPONSE	EXPLANATION
BKB xxxx	CR-LF	Sets the black level of one channel with respect to the other where xxxx ranges between –128 and 127.
BKB?		Queries the current black level balance setting.

Sample Commands with Arguments:

BKB 0 Sets the black level balance to a value of 0.
BKB -100 Sets the black level balance to a value of -100.
BKB 30 Sets the black level balance to a value of 30.

NOTE: This command is not applicable for single channel model, *Mega*Plus Model 1.0/SC.

3.4.14 Digital Gain

Sets the camera gain to a factor 1, 2 or 4.

TYPE IN:	RESPONSE	EXPLANATION
DGN 1	CR-LF	Sets the camera gain to unity.
DGN 2	CR-LF	Sets the camera gain to times two. (Disabled for 10 bit operation)
DGN 4	CR-LF	Sets the camera gain to times four. (Disabled for 10 bit operation)
DGN?		Queries the current gain setting.
	DGN x	Indicates that the gain is set to the factor value given.

3.4.15 Gain Balance

The gain of the two output video channels must be matched to minimize line-to-line shading. The gain balance command adjusts the gain of one channel with respect to the other. The adjustment range is from -128 to 127. With the camera in dual channel readout mode observe a uniform white field with a video amplitude of 70% on the video monitor. Change the gain balance until the best possible image is obtained.

TYPE IN:	RESPONSE	EXPLANATION
GAB xxxx	CR-LF	Sets the gain of one channel with respect to the other where xxxx ranges between –128 and 127.
GAB?		Queries the current gain setting.

Sample Commands with Arguments:

GAB 0	Sets the gain balance to a value of 0.
GAB -100	Sets the gain balance to a value of -100.
GAB 30	Sets the gain balance to a value of 30.

NOTE: This command is not applicable for single channel model, *Mega*Plus Model 1.0/SC.

3.4.16 Restore Factory Settings

Use this command to return the camera black level balance and gain balance settings to the original values set by the factory.

TYPE IN:	RESPONSE	EXPLANATION
RFS	CR-LF	Restores the factory settings for black level balance and gain balance.

3.4.17 Strobe Polarity

The strobe output on the rear panel of the camera provides a trigger pulse for the user. The polarity of the strobe signal is set by this command. The strobe output can drive a 50-ohm load and has a pulse width of 600 nanoseconds in older cameras. Cameras with software version 3.21 or higher have a strobe pulse width of 5µseconds; however the strobe pulse width is 600 nanoseconds in trigger double exposure mode.

TYPE IN:	RESPONSE	EXPLANATION
STP P	CR-LF	Sets the polarity of the strobe output pulse to positive.
STP N	CR-LF	Sets the polarity of the strobe output pulse to negative.
STP?		Queries the strobe output polarity.

3.4.18 Defect Conceal

Sensors are not perfect and have some areas that react differently to light. These imperfect pixels are seen as a column that is different in intensity from its neighbors. The sensor is characterized to locate defective columns. The defective column locations are then programmed into the camera at the factory. When defect concealment is turned on, the camera replaces the defective areas with information derived from nearby pixels making the defects disappear. This image enhancement circuitry maximizes image uniformity.

TYPE IN:	RESPONSE	EXPLANATION
DEF ON	CR-LF	Enables defect concealment.
DEF OF	CR-LF	Disables defect concealment.
DEF?		Queries the state of defect concealment.

3.4.19 Save

TYPE IN:	RESPONSE	EXPLANATION
SAV	CR-LF	Saves the current camera settings to EEPROM; these settings will be recalled by performing a reset or turning the camera power on.

3.4.20 Reset

TYPE IN:	RESPONSE	EXPLANATION
RST	CR-LF	Resets the camera to the settings as last saved. Removing and then restoring power to the camera also performs a reset.

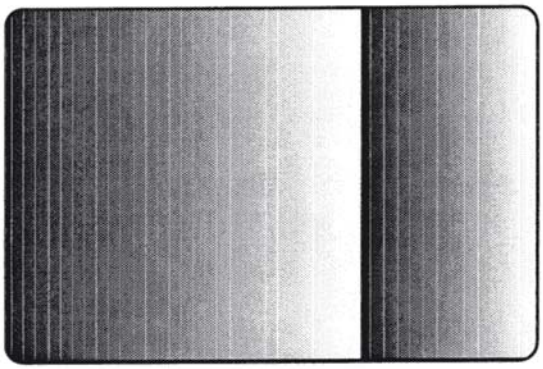

Figure 3-2. Wedge Display

3.4.21 Display Wedge

The wedge command displays linearly increasing gray scales in each quadrant of the image as shown in Figure 3-2. This function is useful for aligning the camera image to a frame grabber. The display wedge defaults to OFF when the power to the camera is turned off.

TYPE IN:	RESPONSE	EXPLANATION
WDG ON	CR-LF	Means the wedge is being displayed.
WDG OF	CR-LF	Means the camera is imaging.
WDG?		Queries the state of the wedge display.

3.5 Query Commands

3.5.1 Status Query

The status query command enables the user to get all of the camera's operating parameter information with a single command.

TYPE IN:	RESPONSE	EXPLANATION
STS?		Gives complete camera status with one query. Each parameter listed below is followed by a carriage return.

RESPONSE	DEFINITION	EXAMPLE
DEF xx	Shows defect conceal status.	DEF ON
GAB xxxx	Shows the gain balance setting.	GAB 36
BKB xxxx	Shows the black level balance setting.	BKB –17
BKE xxxx	Shows black level setting.	BKE 58
MDE xx	Shows the operating mode.	MDE CS
EXE xx	Shows the exposure time.	EXE 58
STP x	Shows the polarity of the strobe pulse.	STP N
TRM x	Shows the trigger logic polarity.	TRM P
TRS xxx	Shows the trigger source setting.	TRS AIA
TRE x	Shows the exposure state.	TRE 1
RDM x	Shows the readout mode.	RDM 2
TPD xxx	Shows the transfer pulse delay.	TPD 150
TPW x	Shows the transfer pulse width.	TPW 5
DGN x	Shows the digital gain setting.	DGN 1

3.5.2 Identification Query

This command queries the camera for its model number and software version.

TYPE IN:	RESPONSE	EXPLANATION
IDN?		Queries the camera for model number and software version.
	MEGAPLUS Model ES 1.0, Vx.xx	

4. INTERFACE SPECIFICATIONS

4.1 Introduction

Chapter 4 gives you the information needed to interface the *Mega*Plus Camera, Model ES 1.0, to a frame grabber device. The *Mega*Plus camera is a megaresolution black and white camera with dual eight or ten bit digital video output. Each frame has 1,008 columns and 1,018 rows of pixels (picture elements) containing valid video data.

4.2 AIA Interface Connector

All of the signals referred to in this section are present at the AIA interface connector on the rear panel of the camera. Table 1 lists each signal and its pin number. The connector for this port is a 68-pin, high density, dual row, D type connector. This connector is the same as that used for the "SCSI-2 B cable" interface. The connector has 0.050 inch (0.127 cm) pin spacing and a D-type shell that is 2.5 inches (6.35 cm) long.

4.3 Digital Video Outputs

The camera has two digital video output channels, A and B, each with eight or ten bits labeled MSB through MSB-7 or MSB-9. The MSB is the Most Significant Bit and MSB-7 or MSB-9 is the LSB (Least Significant Bit) in your camera configuration. These signals are output as differential pairs with signal levels conforming to the EIA-644 (LVDS) specification. The noninverting part of the differential pair is present on the output labeled (+), while the inverting part of the differential pair is present on the output labeled (-).

4.4 Timing Outputs

There are three timing outputs presented on the AIA interface connector. They are FRME ENA (frame enable), LINE ENA (line enable) and PIX DATA STRB (pixel data strobe). These signals are output as differential pairs with signal levels conforming to the EIA-644 specification. The noninverting part of the differential pair is present on the (+) output, while the inverting part of the differential pair is present on the (-) output. A signal is true when the (+) line is more positive than the (-) line.

4.5 Control Inputs

The control input EXPOSE is provided as a means of externally synchronizing the camera. This input is designed to accept RS-422 differential, or single ended TTL. To drive this input differentially connect both the (+) and (-) inputs to an RS-422 driver. Connect one input to a TTL driver and leave the other input floating to drive the EXPOSE input from a single ended signal source.

Table 4-1. AIA Interface Connector Pin Out (on rear of camera)

SIGNAL NAME	PIN	SIGNAL NAME	PIN	SOURCE
GROUND	1	GROUND	35	Both
AMSB (+)	2	AMSB (-)	36	Camera
AMSB-1 (+)	3	AMSB-1 (-)	37	Camera
AMSB-2 (+)	4	AMSB-2 (-)	38	Camera
AMSB-3 (+)	5	AMSB-3 (-)	39	Camera
AMSB-4 (+)	6	AMSB-4 (-)	40	Camera
AMSB-5 (+)	7	AMSB-5 (-)	41	Camera
AMSB-6 (+)	8	AMSB-6 (-)	42	Camera
AMSB-7 (+)	9	AMSB-7 (-)	43	Camera
BMSB (+)	10	BMSB (-)	44	Camera
BMSB-1 (+)	11	BMSB-1 (-)	45	Camera
GROUND	12	GROUND	46	Both
BMSB-2 (+)	13	BMSB-2 (-)	47	Camera
BMSB-3 (+)	14	BMSB-3 (-)	48	Camera
BMSB-4 (+)	15	BMSB-4 (-)	49	Camera
BMSB-5 (+)	16	BMSB-5 (-)	50	Camera
RESERVED	17	RESERVED	51	
RESERVED	18	RESERVED	52	
BMSB-6 (+)	19	BMSB-6 (-)	53	Camera
BMSB-7 (+)	20	BMSB-7 (-)	54	Camera
AMSB-8 (+)	21	AMSB-8 (-)	55	Camera
SER CNTRL OUT (+)	22	SER CNTRL OUT (-)	56	Camera
SER CNTRL IN (+)	23	SER CNTRL IN (-)	57	User
Not used	24	Not used	58	
FRME ENA (+)	25	FRME ENA (-)	59	Camera
LINE ENA (+)	26	LINE ENA (-)	60	Camera
Not used	27	Not used	61	
Not used	28	Not used	62	
PIX DATA STRB (+)	29	PIX DATA STRB (-)	63	Camera
EXPOSE (+)	30	EXPOSE (-)	64	User
AMSB-9 (+)	31	AMSB-9 (-)	65	Camera
BMSB-8 (+)	32	BMSB-8 (-)	66	Camera
BMSB-9 (+)	33	BMSB-9 (-)	67	Camera
GROUND	34	GROUND	68	Both

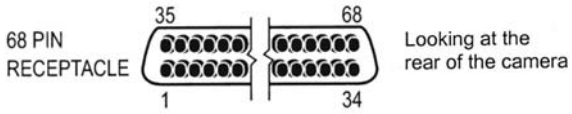

Figure 4-1. AIA Interface Connector

4.6 Cable Descriptions

Refer to Table 4-1 for cable pin out.

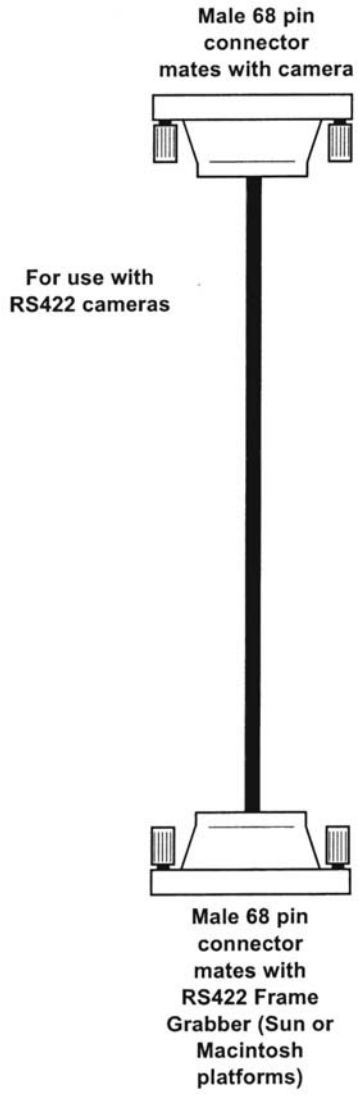

Figure 4-2 AIA Interface Cable

Table 4-2. Interface Cable Pin Out, Mates with PC COM Port

SIGNAL NAME	PIN	SIGNAL NAME	PIN	Source
GROUND	1	GROUND	35	Both
AMSB (+)	2	AMSB (-)	36	Camera
AMSB-1 (+)	3	AMSB-1 (-)	37	Camera
AMSB-2 (+)	4	AMSB-2 (-)	38	Camera
AMSB-3 (+)	5	AMSB-3 (-)	39	Camera
AMSB-4 (+)	6	AMSB-4 (-)	40	Camera
AMSB-5 (+)	7	AMSB-5 (-)	41	Camera
AMSB-6 (+)	8	AMSB-6 (-)	42	Camera
AMSB-7 (+)	9	AMSB-7 (-)	43	Camera
BMSB (+)	10	BMSB (-)	44	Camera
BMSB-1 (+)	11	BMSB-1 (-)	45	Camera
GROUND	12	GROUND	46	Both
BMSB-2 (+)	13	BMSB-2 (-)	47	Camera
BMSB-3 (+)	14	BMSB-3 (-)	48	Camera
BMSB-4 (+)	15	BMSB-4 (-)	49	Camera
BMSB-5 (+)	16	BMSB-5 (-)	50	Camera
RESERVED	17	RESERVED	51	
RESERVED	18	RESERVED	52	
BMSB-6 (+)	19	BMSB-6 (-)	53	Camera
BMSB-7 (+)	20	BMSB-7 (-)	54	Camera
AMSB-8 (+)	21	AMSB-8 (-)	55	Camera
RESERVED	22	RESERVED	56	
RESERVED	23	RESERVED	57	
Not used	24	Not used	58	
FRME ENA (+)	25	FRME ENA (-)	59	Camera
LINE ENA (+)	26	LINE ENA (-)	60	Camera
Not used	27	Not used	61	
Not used	28	Not used	62	
PIX DATA STRB (+)	29	PIX DATA STRB (-)	63	Camera
EXPOSE (+)	30	EXPOSE (-)	64	User
AMSB-9 (+)	31	AMSB-9 (-)	65	Camera
BMSM-8 (+)	32	BMSM-8 (-)	66	Camera
BMSM-9 (+)	33	BMSM-9 (-)	67	Camera
GROUND	34	GROUND	68	Both

Table 4-3. 9-Pin Connector Pin Out

SIGNAL NAME	PIN	SIGNAL NAME	PIN
Open	1	Open	6
Transmit (TX) from Camera	2	Connected to pin 8	7
Receive (RX) from User	3	Connected to pin 7	8
Open	4	Open	9
Ground	5		

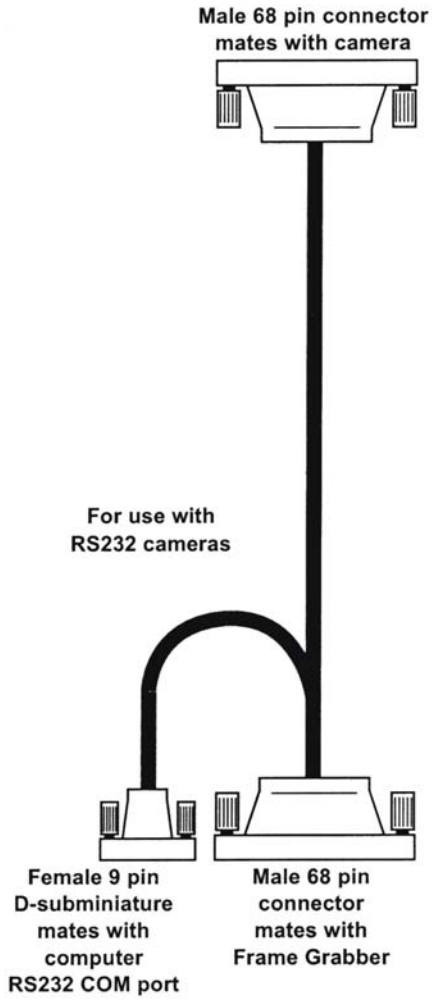

Figure 4-3. Interface Cable

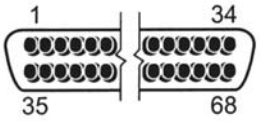

Figure 4-4. Interface Cable Connector

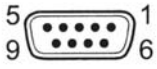

Figure 4-5. COM Port 9-Pin Cable Connector

Table 4-4. 37-Pin Interface Cable Pin Out (ES 1.0/SC Model Only)

SIGNAL NAME	PIN	SIGNAL NAME	PIN	Source
PIX DATA STRB (+)	1	PIX DATA STRB (-)	20	Camera
LINE ENA (+)	2	LINE ENA (-)	21	Camera
FRME ENA (+)	3	FRME ENA (-)	22	Camera
GROUND	4	GROUND	23	Camera
Not Used	5	Not Used	24	
Reserved	6	Reserved	25	
Reserved	7	Reserved	26	
MSB-7 (+)	8	MSB-7 (-)	27	Camera
MSB-6 (+)	9	MSB-6 (-)	28	Camera
MSB-5 (+)	10	MSB-5 (-)	29	Camera
MSB-4 (+)	11	MSB-4 (-)	30	Camera
MSB-3 (+)	12	MSB-3 (-)	31	Camera
MSB-2 (+)	13	MSB-2 (-)	32	Camera
MSB-1 (+)	14	MSB-1 (-)	33	Camera
MSB (+)	15	MSB (-)	34	Camera
GROUND	16	GROUND	35	Camera
EXPOSE (-)	17	EXPOSE (+)	36	Camera
Not Used	18	Not Used	37	
Not Used	19			

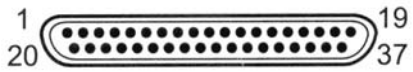

Figure 4-6. 37-Pin Connector (ES 1.0/SC Only)

Table 4-5. COM Port 9-Pin Cable Pin Out (ES 1.0/SC Only)

SIGNAL NAME	PIN	SIGNAL NAME	PIN	Source
PIX DATA STRB (+)	1	PIX DATA STRB (-)	20	Camera
LINE ENA (+)	2	LINE ENA (-)	21	Camera
FRME ENA (+)	3	FRME ENA (-)	22	Camera
GROUND	4	GROUND	23	Camera
Not Used	5	Not Used	24	
Reserved	6	Reserved	25	

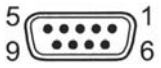

Figure 4-7. COM Port 9-Pin Connector (ES 1.0/SC Only)

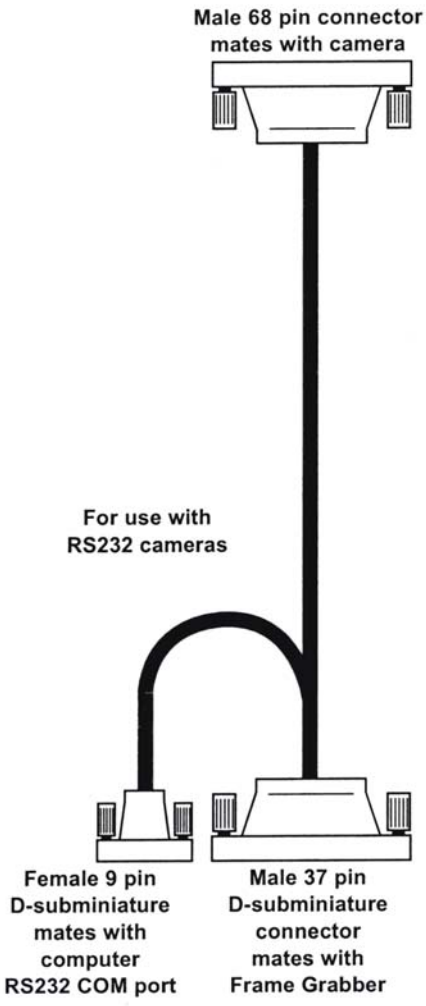

Figure 4-8. 37-Pin Interface Cable with 9-Pin COM Port Cable (ES 1.0/SC Only)

4.7 Timing Waveforms

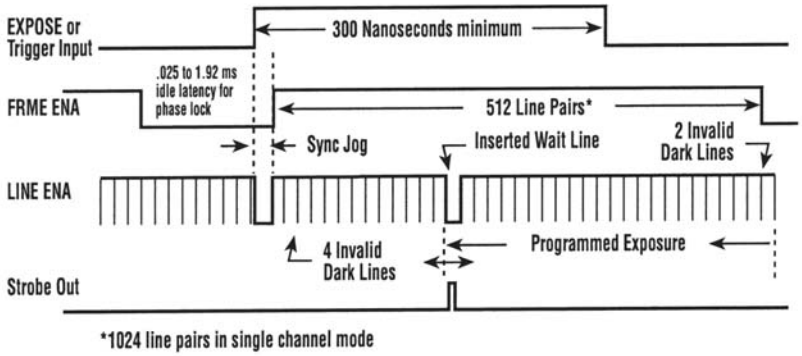

Figure 4-9. Continuous Mode – Variable Exposure Timing

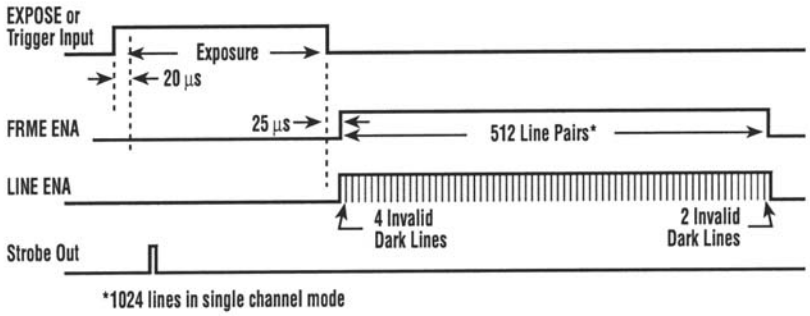

Figure 4-10. Controlled Mode Timing

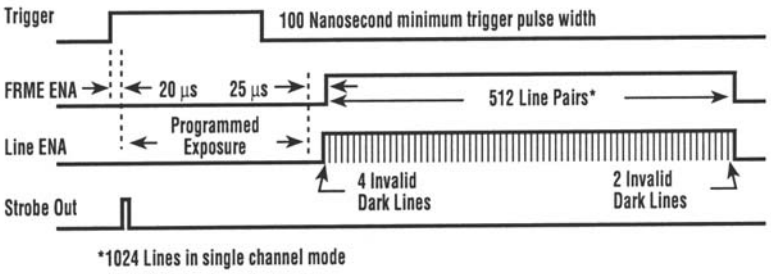

Figure 4-11. Triggered Mode Timing

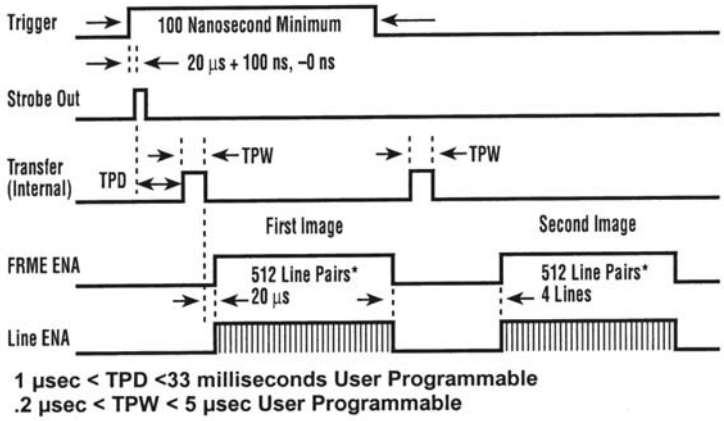

Figure 4-12. Triggered Double Exposure Mode Timing

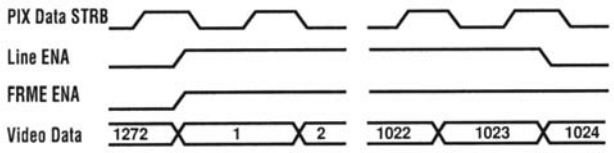

Figure 4-13. Line Timing

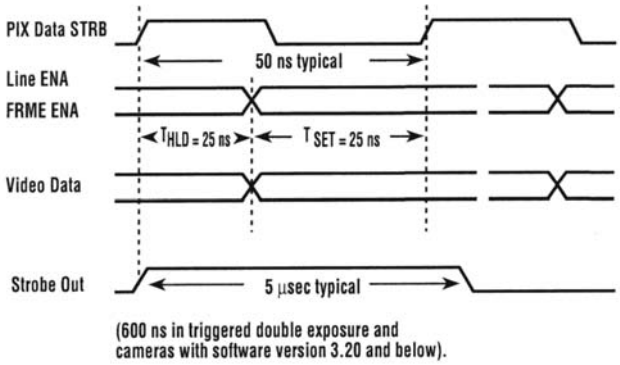

Figure 4-14. Pixel Timing

4.8 Specifications

4.8.1 Video Performance

Black Level:	Clamped to black reference at the start of each frame.
Gamma:	Unity.
Scanning:	Non-interlaced, progressive.
Synchronization:	Pixel clock internal.
Dynamic Range:	48 dB 8-bit, ≥58 dB 10-bit.
Antibloom:	100 times at 30-millisecond exposure with a gain of 1.
Pixel Clock Rate:	20 MHz.
Frame Rate:	≈30 fps in dual channel mode, ≈15 fps in single channel mode.

4.8.2 Camera Mechanical

Housing:	Two piece sheet metal steel case.
Dimensions:	2.0” H x 2.7” W x 6.0” L (50.8 x 68.6 x 152.4mm).
Lens:	C-Mount.
Weight:	Approximately 1.5 pounds (0.68 Kg).
Mount:	One ¼ -20 threaded hole with locating pin hole.
Vibration:	3G, sinusoidal from 5 to 150 Hz.
Shock:	20G (non-operating).

4.8.3 Temperature

Operating:	0 to 40°C (32 to 104°F), non-condensing (Image quality will degrade with increasing temperature)
Storage:	-25 to +80°C (-13 to 176°F), non-condensing.

4.8.4 Humidity

Operating:	<80% @ 40°C (104°F).
Storage:	<40% @ 80°C (176°F).